

Yesterday, Today & Tomorrow: Best Practice for CSF Sampling of an EVD to Minimise Patient Risk

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Abstract

Managing raised intracranial pressure (ICP) with the use of an external ventricular drain (EVD) is a common occurrence in a neurosurgical setting. A central role of the neuroscience nurse in managing that EVD is to monitor the patient for signs and symptoms of infection otherwise known as ventriculitis. Cerebrospinal fluid (CSF) sampling from an EVD has historically been completed as a daily routine specimen to monitor for any signs of infection. However, in more recent times there has been evidence to suggest that specimens should only be collected when infection or ventriculitis is suspected to minimise the interruption of the closed system. Different practices have been identified related to the frequency of sampling, the best solution for decontamination of the sampling site/port and preferable port for obtaining the specimen. Our aim was to complete an integrative literature review. Medline Complete and CINAHL were searched and articles were screened. Nine articles were used to form the integrated review. The main findings were collated and found that daily sampling is no longer recommended. The proximal port was the most popular choice for sampling. Decontaminating solutions used for accessing an EVD varied with no evidence to support the choice of solution. Findings of the majority of papers were focussed on sampling frequency and other associated ways to minimise infection rather than choice of sampling site or the use of specific decontaminating solutions.

Keywords: *External ventricular drain, cerebrospinal fluid, ventriculitis, sampling.*

Introduction

In the clinical setting, sampling cerebrospinal fluid (CSF) from an external ventricular drain (EVD) is a skill required of a neuroscience nurse. Neurosurgical ward guidelines and hospital policies often conflict with what is perceived as common practice by neurosurgeons. This impacts on the consensus of what would be considered best practice for sampling CSF, including from which port the sample should be obtained and which solution should be used to decontaminate the access portal. The insertion of a ventricular catheter interrupts what is normally a closed ventricular system inside the cranium, which in turn places the patient at significant risk of complications. One of the most common complications is ventriculitis (Kitchen, Singh, Hulme, Galea, Patel & King, 2011).

Interest in the topic began when nursing staff were asked to obtain a CSF sample by the medical staff. The hospital policy was obtained from the intranet. Accessing and reviewing of the policy was followed by a dis-

cussion with the medical staff about what is best practice for CSF sampling. Several neurosurgeons were questioned about best practice for CSF sampling from an EVD. From the discussions it was clear there was a lack of consensus amongst them. Some neurosurgeons stated they tended to follow what other medical staff preferred due to the lack of evidence available. Following these discussions a brief review of current data regarding best practice was completed and four other metropolitan hospitals were benchmarked for their practices in CSF sampling. There was no consensus on what was best practice according to other major hospitals and credible resources. It was obvious that an integrated review was necessary to be able to establish a best practice guideline for CSF sampling. The following paper will attempt to integrate the literature findings relating to best practice for CSF sampling including which port should be accessed, the frequency of sampling and which decontaminating solution should be used.

Aim

To formulate an integrated review to answer the questions:

1. Which port should be accessed?
2. Which is the best cleansing solution to be used?

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3. How often should a CSF sample be taken?

Method

In March 2014 the bibliographic databases Medline Complete and CINAHL were searched (see Figure 1) using the following keywords, external ventricular drain, cerebrospinal fluid, infection, ventriculitis, specimen, sampling. There were no date limits set for the search. The inclusion criteria were original quantitative research papers that had been peer reviewed and related to EVDs, sampling CSF and minimising infection. The exclusion criteria were articles not written in English. Medline Complete returned 30 articles and CINAHL returned 3. After two duplications were removed and title screening complete, the abstracts of the final 10 were reviewed. Nine full text articles were used to form the integrated review.

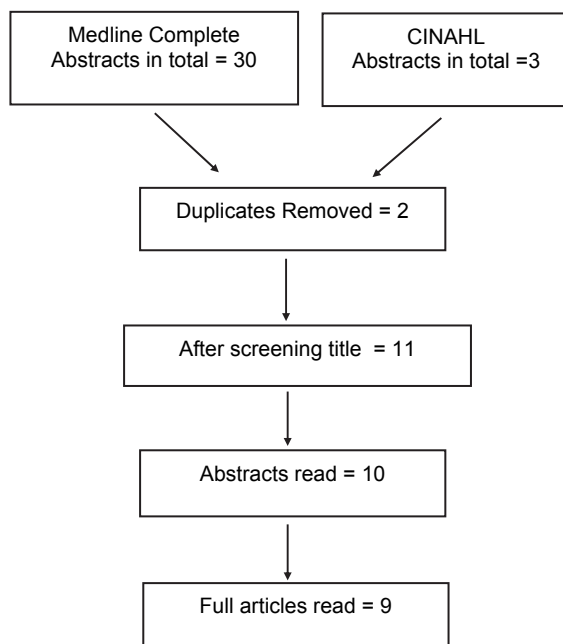


Figure 1: (Above) Process for selection of articles

Results

From 33 articles only nine papers were included in the review. The main findings of these papers were collated. Findings showed that there were varied recommendations and opinions about the frequency of CSF sampling. Daily sampling is no longer recommended (Williamson, Phillips-Bute, McDonagh, Gray, Zomorodi, Olson & James, 2014; Williams, Leslie, Dobb, Roberts & van Heerden, 2011) in most articles but the optimum frequency for sampling remains unclear. The sampling site was discussed in very few papers. The proximal port was the

most commonly used site for sampling (Muttaiyah, Ritchie, Upton & Roberts, 2008; Hoefnagel, Dammers, Ter Laak-Poort & Avezaat, 2008; Korinek, Reina, Boch, Rivera, De Bels & Puybasset, 2005). Only one paper by Wong (2011) discussed alternate sampling sites in view of minimising infection. Many papers did not state the decontaminating solution used for accessing the port to sample CSF. The main findings of the papers focussed on sampling frequency and associated ways to minimise infection and not sampling site or the use of specific decontaminating solutions (Hoefnagel et al., 2008; Kitchen et al., 2011; Korinek et al., 2005; Lwin, Low, Choy, Yeo & Chou, 2012; Muttaiyah et al., 2008; Pfisterer, Muhlbauer & Reinprecht, 2003; Williams et al., 2011; Williamson et al., 2014).

Discussion

Frequency of sampling

CSF samples are taken breaking the seal of a closed system. The technique must be done aseptically and only by trained medical or nursing staff (Kitchen et al., 2011). Every sample taken and each manipulation of the system is associated with increased risk of introducing infection into the closed system (Williamson et al., 2014). Frequency of sampling required for a patient with an EVD is often a conflict between whether it is appropriate to sample daily so that samples can be tested for infection or that frequency should be reduced to only when patient is showing signs of sepsis as CSF sampling increases the risk of infection such as ventriculitis (Lwin et al., 2012).

Within the nine articles chosen for review, the preferred frequency of sampling was not always evident but the findings generally led to a discussion regarding whether increased frequency of sampling lead to the increased risk of ventriculitis. In a retrospective study by Muttaiyah et al., (2008), a daily sample of CSF was taken and an analysis was conducted looking mainly at clinical parameters predicting infection. From the pathology results of the CSF samples collected, Muttaiyah et al., (2008) indicated that a change in Glasgow Coma Scale (GCS) score and/or a change in temperature of a patient with an EVD was not a reliable link to indicate daily CSF sampling rather, it increased the risk of ventriculitis. They also noted that these neurological and metabolic changes were not a reliable indicator for early prediction of ventriculitis. However, they did conclude that further evidence would be required and larger

prospective study would provide more reliable results.

A prospective study by Pfisterer et al., (2003) used daily CSF sampling as a method in their study to examine early diagnosis of EVD infection. They concluded that there was no correlation between drainage time and a high CSF cell count which would indicate infection. They also concluded that samples that had a high CSF cell count were more likely to be contaminated specimens rather than EVD related infections. Their prospective methodology tends to yield more accurate results given the ability to control certain points and variables. Pfisterer et al., (2003) concluded as did Muttaiyah et al., (2008) that patients were generally very unwell and unable to communicate signs and symptoms of an infection and therefore daily specimens were required. The focus of Pfisterer's et al., (2003) study was mainly looking at the association of drainage time and infection. Despite this they did conclude that daily CSF sampling of an EVD did not increase the risk of ventriculitis.

Hoefnagel et al., (2008), used a retrospective single centre study design that investigated complications such as meningitis and ventriculitis occurring in patients with EVDs. The neurosurgical department protocol was to sample CSF from the EVD three times a week as well as on removal of the EVD. In contrast to the previous studies, Hoefnagel et al., (2008) found that there was a significant increase in infection rates with CSF sampling as well as the duration of EVD drainage. They found that the more the EVD had CSF samples taken the higher the risk of infection such as ventriculitis. The authors concluded that CSF samples should only be taken when infection is suspected and should be based on other predictors of infection such as a meningism and fever. However, there are limitations with the study design as single centred retrospective studies left information uncontrolled. EVDs were also flushed when blocked and other issues were indicated that may have increased infection rates.

A similar study by Williams et al., (2011) showed a significant link of increased infections such as ventriculitis with increased CSF sampling of an EVD. Their study showed that reducing the frequency sampling to every third day, as well as sampling when clinically indicated, would significantly reduce the percentage of reported proven cases of ventriculitis. Again limitations are noted with the study

by Williams et al., (2011) as EVD treatment varied and their control group was previously admitted patients, which had less control over data alterations and collections.

Other studies such as Lwin et al., (2012) looked at reducing rates of infection such as meningitis and ventriculitis by reviewing techniques of how often CSF samples were taken, EVD insertion techniques and how long EVDs stayed in place. A retrospective audit was used in which they introduced a different type of EVD system as well as thorough nurse education. Their study had other significant factors which could explain why infection rates were decreased in their sample results and would not necessarily be a reliable indicator for CSF sampling frequency. These factors were staff education, a hand hygiene regime for staff, multiple testing on positive CSF samples to rule out external contamination and the use of a silver coated EVDs rather than the commonly used system in the retrospective data. It still showed that sampling only when there were clinical signs and symptoms of sepsis had a substantially reduced infection rate among the patient samples they tested. It needs to be noted that in the study by Lwin et al., (2012) they had omitted useful data such as information about sampling, temperatures of patients and GCS decline which are all important indicators of infection. Another study by Korinek et al., (2005) had a similar conclusion but a different way of obtaining the result. Their study initially compared second daily sampling of an EVD to related results of increased infection rate. They also discussed the seemingly evident issues of whether the incidence of true ventriculitis was actually a correct diagnosis as most studies that have been reviewed here have been retrospective and usually only rely on a positive CSF culture without taking into account the clinical and CSF biochemical data. They concluded that changing from 2nd daily sampling of CSF to sampling only when signs and symptoms of sepsis were indicated, reduced the amount of EVD infections.

Interestingly, the integrated review conducted here highlighted two articles that had a different approach to frequency sampling and associated EVD infections. A retrospective study by Williamson et al., in 2014 specified that sampling was only taken at the medical team's discretion. The study aimed to determine the predictors of bacterial ventriculitis. They concluded that EVD related bacterial ventriculitis generally occurred after the 3rd

daily sample of CSF. From further review of the article it was evident to Williamson et al., (2014) that there was an associated link between CSF sampling and EVD-related bacterial ventriculitis and that specimens should only be taken at the medical team's discretion when clinical evidence of sepsis is noted. Kitchen et al., (2011) also conducted a study that initiated the sampling of CSF from a patient's EVD at the medical team's discretion. It was a prospective study that determined that frequency in sampling did not increase the risk of EVD associated infections as long as the clinicians had adequate experience and used theatre-standard aseptic technique. However, this study did remove and reinsert the EVDs when blocked which would alter the data.

Sampling site

To sample CSF from a patient with an EVD, the sample can be obtained from multiple sites. These include - directly from the EVD, a specifically designed CSF port, and a three way tap or from the collection chamber or drainage bag. In general the sample ports are referred to as a proximal port (closest to the patient's head) or a distal port (further away from the patient's head).

Wong (2011), completed a quasi-experimental study using a convenience sample looking for a safe and easy port to obtain accurate results, whilst minimising opening of the closed system. The 47 patients involved in the study had a pair of CSF samples removed at midnight, daily from the proximal port first, followed immediately by a distal port sample. The findings revealed that proximal port sampling may increase the risk of infection due to proximity of the patient's head and being less secure than the distal port. However many of the study limitations included varied indications for EVD insertion, the length of insertion time varied from 1- 23 days and there was a low infection rate in the study. CSF specimens containing blood were also not analysed in this study by Wong (2011). In addition, distal port samples included only some of the CSF from the collection chamber at the time. The writer indicates the possibility for white blood cells (WBC) to sit on the bottom of the collection chamber giving a false high if the whole collection chamber was not sampled.

The retrospective study by Muttaiyah et al., (2008) stated that samples were obtained from a proximal port. No rationale for port selection was discussed, despite concluding

that larger studies are required to identify if reduced frequency of sampling is safe.

Hoefnagel et al., (2008) did not identify that sampling from the proximal port increased infection despite the study discussing risk factors for EVD-related infections. Again the rationale for port selection was not discussed. The small retrospective study did state frequent sampling appeared to be a risk factor for EVD infection.

An abnormal CSF result obtained from the drainage collection bag was used as a prompt for a second sample to be drawn proximally in a prospective study by Korinek et al., in 2004. Changes in neurological state or a fever of unknown origin were the only indicators for CSF sampling. Korinek et al., (2004) did not discuss the rationale as to why a sample from a collection-bag was taken first and why then if that specimen was abnormal a second sample was then taken from the proximal site. Despite the sampling order, Korinek et al., (2004) did conclude that inappropriate or routine sampling be avoided. Comparison of the two samples obtained from patients requiring CSF analysis, were not evaluated in the paper by Korinek et al., (2004).

Around half of the articles reviewed did not indicate or provide enough evidence to ascertain from where the CSF sample was retrieved. An EVD has several sample sites as discussed depending on the drainage system attached. Whilst most articles focus on infection related to sampling frequency and other contributing factors, further research into specific sampling sites may contribute to decreasing EVD-related ventriculitis as indicated by Wong (2011).

Decontaminating Solution

Decontamination solution was the last question to be answered relating to best practice for EVD sampling of CSF specimens. Unfortunately the majority of the articles reviewed did not elaborate on what solutions were used. When decontamination of the port was discussed the specific decontaminating solution was omitted.

Muttaiyah et al., (2008) and Pfisterer et al., (2003) both stated they used a chlorhexidine 2% alcohol combination to swab their chosen EVD port or sample site. Pfisterer et al., (2003) used chlorhexidine ethanol solution, stating a meticulous disinfection of the port site was completed when manipulating the EVD system. The detail of the specific solu-

tion was not mentioned.

Hoefnagel et al., (2008) indicated an alcohol solution was used on the chosen port. Lwin et al., (2012) used a type of antiseptic that was not directly identified but stated the ports were thoroughly cleaned prior to sampling. Four articles out of nine chose to mention what cleansing solution was used. Five of the articles did not discuss what decontaminating solution was used. The integrated review of all articles found that the decontaminating solution was not discussed as a risk factor in relation to EVD-related infections or CSF sampling. Potentially one solution may be better than another but further research is required.

Limitations

The studies reviewed did not provide a consensus and there were limitations in study design, sample size and data collection. Retrospective studies tended to have missing data as well as lack of control over information. Lack of past health history of patients was also noted. No information was given on whether patients had infections prior to the EVD insertion and few studies discussed why the patient required an EVD. EVD protocols were not discussed in the majority of papers, so there was uncertainty and lack of information around who took the specimen, what type of aseptic technique was used, what equipment they used and whether or not it was protocol to have prophylactic antibiotics while the EVD was insitu.

Conclusion

An EVD breaks what is normally a closed ventricular system, increasing the risk of infection regardless of the frequency, port and decontaminating solution used to obtain a CSF sample.

This integrated review found that daily CSF sampling from an EVD is not recommended due to the increased chance of developing infection or ventriculitis. The preferred access port utilised for sampling is the proximal port. However, this was not the focus of the majority of studies and articles reviewed. Unknown sample sites and a lack of discussion of the risks of sampling sites, indicates an area for further inquiry.

A lack of discussion of decontaminating solution throughout the review indicates that there are no evidence-based preferences or conclusions as to what solution is recommended for decontaminating access ports to

minimise infection such as ventriculitis.

Based on the integrative review conducted, a large prospective study over multiple sites is needed. Rigid and detailed protocols for EVD management and CSF sampling would be required to provide evidence for best practice for EVD management and CSF sampling.

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